



Central Coast Groundwater: Seawater Intrusion and Other Issues

August 4, 2014



Prepared by Julie Nico Martin

Commissioned by the California Water Foundation

Groundwater Issues Along California's Central Coast

Executive Summary

The Central Coast area relies on groundwater for more than 80 percent of its water supplies, a greater percentage than any other region in the state. Over 40 percent of the groundwater basins in the Central Coast region were ranked as either “high” or “medium” priority as part of the California Statewide Groundwater Elevation Monitoring (CASGEM) prioritization released in June 2014, indicating that they are among the most threatened by present or future increases in groundwater demand. Central Coast groundwater supplies are seriously threatened by over-pumping that causes seawater intrusion, a challenge unique to coastal communities. Seawater intrusion results in saline groundwater that is unsuitable for irrigation or domestic use, directly threatening the Central Coast's economy, where many high-value, salt-sensitive crops, such as strawberries, are grown.

Groundwater basins in the Monterey and Salinas Valley area are in a state of long-term overdraft, resulting in falling groundwater levels, regional seawater intrusion, and reduced groundwater storage. Seawater intrusion reaches more than five miles inland in the Salinas Valley and three miles inland in the Pajaro Valley. In addition to salinity issues, several groundwater contaminants are present in these aquifers, including elevated levels of total dissolved solids, iron, manganese, nitrates, and other trace elements.

The Paso Robles groundwater subbasin supplies water for 29 percent of the population and an estimated 40 percent of the agricultural production of San Luis Obispo County. Groundwater levels in the basin have been dropping rapidly in recent years, with many areas experiencing groundwater level declines of more than 70 feet. As a result, many wells have gone dry and groundwater users have been forced to deepen their wells or drill new wells. In July 2013, over 100 rural property owners complained to the San Luis Obispo County Board of Supervisors that their wells were running dry and in August 2013 the Board adopted the “Paso Robles Groundwater Basin Urgency Ordinance” as a temporary action to prevent new pumping from worsening overdraft conditions. Additionally, land surface subsidence has been noted in the Paso Robles area, and the recent rapid groundwater level declines may have triggered additional subsidence in this area.

Although groundwater levels in the Oxnard Plain area have been relatively stable or have shown an increasing trend, in the coastal regions this stability is largely due to seawater intrusion and results in water of unusable quality replacing high quality groundwater. Rising groundwater levels in the Las Posas Valley are a result of active management to increase groundwater recharge beneath the Arroyo Las Posas. Seawater intrusion began in the Oxnard Plain area by 1930s and was widespread as early as the 1940s. Changes in groundwater management, including pumping reductions, shifting of pumping locations, construction of the Freeman Diversion, and the operation of the Pumping Trough and Pleasant Valley pipeline systems have significantly reduced seawater intrusion, but seawater intrusion conditions persist. Other contaminants present in the region include nitrates, iron, manganese and

sulfate. In addition to causing seawater intrusion, over-pumping also caused irreversible land subsidence ranging from 2.5 to 5 feet in several areas of the basin.

The Central Coast is critically dependent upon groundwater, but this resource is under serious threat in a number of basins. In light of the limitations of existing state policies, the following measures would improve the effectiveness of groundwater planning and support sustainable management of California's Central Coast's groundwater resources.

- Establish a statewide policy to manage groundwater sustainably.
- Organize and empower local groundwater agencies to manage groundwater subbasins.
- Require the development and implementation of groundwater sustainability plans by local groundwater agencies.
- Provide local agencies with technical guidance and financial support from the state.
- Empower the State to oversee and ensure the implementation of groundwater sustainability plans.

Introduction

Groundwater is a critical component of California's water supply, used to meet roughly 40 percent of the state's water supply in normal years and 60 percent or more during drier years and droughts. The Central Coast area relies on groundwater for a greater percentage of its water supplies than any other region in the state. According to the California Department of Water Resources (DWR), more than 80 percent of the region's water supplies are from groundwater.

Groundwater is the primary water supply for all major communities along the Central Coast (Table 1). There are eighty groundwater basins in the Central Coast region as defined for this report¹. Over 40 percent of these were ranked as either "high" or "medium" priority as part of the California Statewide Groundwater Elevation Monitoring (CASGEM) groundwater basin prioritization released in June 2014². The CASGEM prioritization rankings provide a system of identifying which basins are of highest priority in the state and are possibly threatened by present or future increases in groundwater demand.

Table 1 - Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

County	Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Total Water Use Met by Groundwater	
	TAF	%	TAF	%	TAF	%
Santa Cruz	17.6	98%	28.9	71%	46.5	79%
San Benito	48.2	74%	7.7	70%	55.9	73%
Monterey	464.2	99%	67.1	100%	531.3	99%
San Luis Obispo	161.2	97%	39.0	74%	200.3	92%
Santa Barbara	186.6	87%	42.1	48%	228.7	76%
Ventura	224.3	73%	26.6	16%	250.8	53%

1) TAF = thousand acre-feet

2) Percent use is the percent of the total water supply that is met by groundwater, by type of use

Source: Table CC-14 and SC-9 from CA Water Plan Update 2013 Public Review Draft.

Overdraft³ in the Central Coast has caused groundwater levels to decline, allowing seawater to move into the coastal aquifers. As seawater moves into an aquifer it causes severe water quality impacts, which can result in saline groundwater that is unsuitable for irrigation or domestic use. Seawater intrusion directly threatens the Central Coast's economy, where many high-value, salt-sensitive crops, such as strawberries, are grown. High salt levels affect the appearance of produce and results in smaller

¹ For the purposes of this report, the Central Coast is defined to include the southern portion of Santa Cruz County and all of Monterey, San Luis Obispo, Santa Barbara, and Ventura Counties, extending from approximately Watsonville in the north to City of Port Hueneme in the South, as shown in Figure 1. This report uses the basin and subbasin boundaries identified in DWR's Bulletin 118. <http://www.water.ca.gov/groundwater/bulletin118/bulletin118update2003.cfm>

² DWR prioritized all 515 alluvial groundwater basins and subbasins in California as part of the California Statewide Groundwater Elevation Monitoring (CASGEM) Program to identify which basins are of highest priority in the state. Basins and subbasins were scored based on eight criteria, ranked by score, and grouped into one of four priority categories: high (>21.08), medium (21.07-13.43), low (13.42-5.75), or very low (<5.75). http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm

³ Overdraft is a condition where more water is pumped than replenishes or recharges an aquifer over a long period of time.

crop yields (Taylor, 2014). It is also a condition that is difficult to reverse and could render the water supply for millions of Californian's undrinkable without billions of dollars in new treatment facilities.

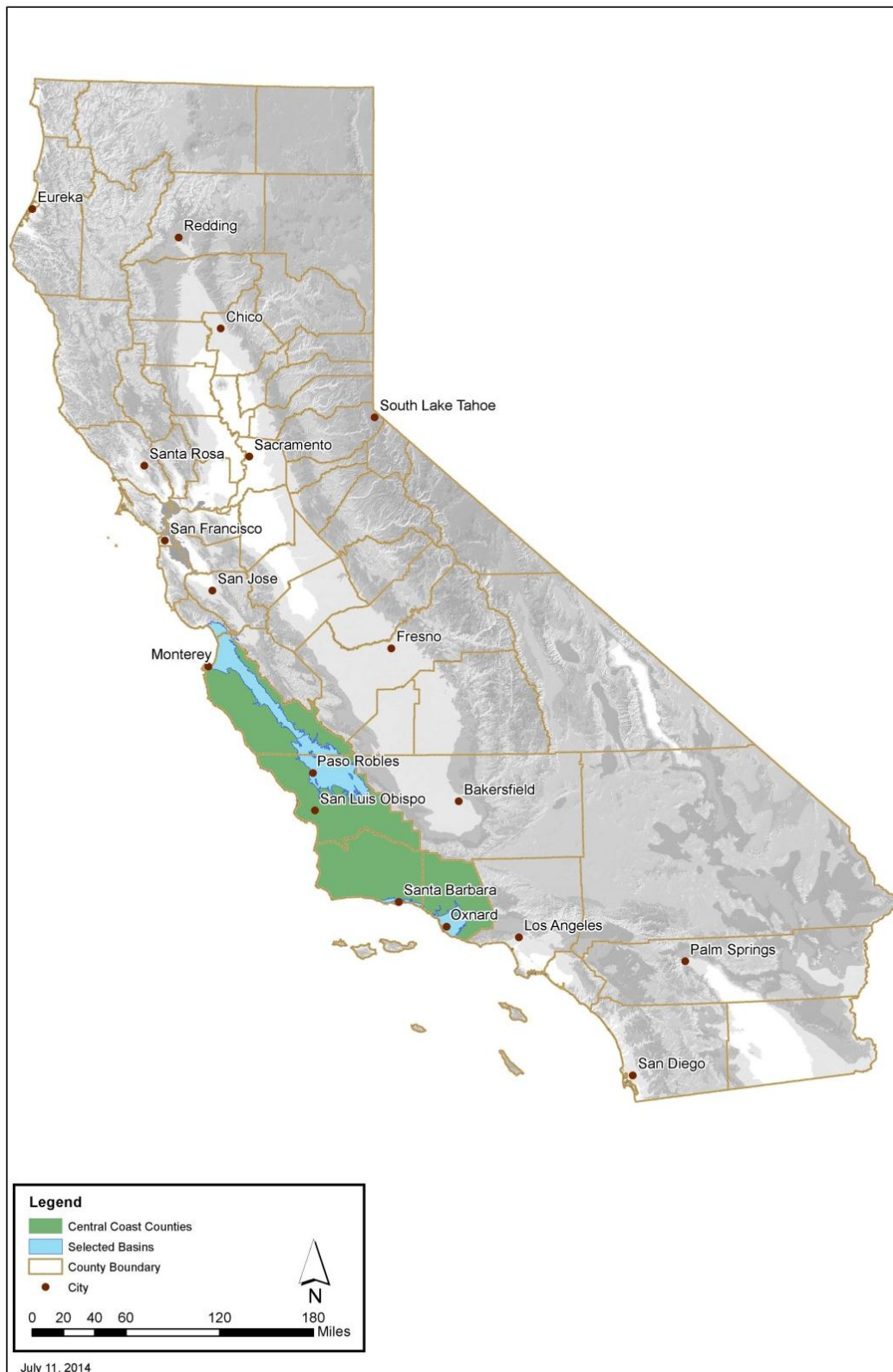
The Central Coast is almost entirely dependent upon local water supplies. Imported water from places like the Sacramento-San Joaquin Delta or the Colorado River is limited and makes up only a small portion of the total supply. Without the possibility of importing additional water resources, there is limited flexibility in water management scenarios and no easy back up plan. As a result, groundwater is a vitally important resource for the region that needs to be managed wisely.

Central Coast water managers are acutely aware of the region's dependence on groundwater and the challenges they face in maintaining a reliable water supply. Local water management entities have formed in several areas and many groundwater management plans have been developed. Many successes have been seen. For example, the rate of seawater intrusion in the Salinas Valley has been dramatically slowed as a result of careful management.

While there are examples of effective management throughout the region, local agencies need new tools to sustainably manage the resource. This report highlights four areas within the Central Coast region: the Monterey and Salinas Valley area, the Paso Robles area, the Santa Barbara area, and the Oxnard area (Figure 1). These areas cover the primary non-adjudicated groundwater basins along the Central Coast and represent a range of groundwater conditions and challenges.⁴ We conclude with a set of recommendations for a management system that would significantly enhance the ability of local agencies to protect groundwater resources along the Central Coast and throughout California.

⁴ The Santa Maria area was excluded because it has been adjudicated. The adjudication process began in 1997 and the ruling was issued in 2008. The ruling was appealed, but in late 2012 a state appellate court upheld the 2008 superior court judgment, and in 2013 the California Supreme Court then refused to hear the case, validating the basin management plan. In basins where a lawsuit is brought to adjudicate the basin, the groundwater rights of all pumpers are determined by the court. Of the 515 groundwater basins in California, 23 are currently adjudicated. While groundwater is now being managed sustainably in many of these basins, adjudications are extremely expensive and can take decades to complete.

Figure 1 - Locations of Focal Groundwater Basins within Central Coast Region



Source: Figure provided by RMC Water and Environment.

Monterey and Salinas Valley Area

The Monterey and Salinas Valley area depends heavily on groundwater for both agricultural and urban water supply. As shown in Figure 2, there are two major groundwater basins in this area: the Pajaro Valley basin and the Salinas Valley groundwater basin, which includes eight subbasins: the 180/400 foot Aquifer, Langley Area, East Side Aquifer, Forebay Aquifer, Upper Valley Aquifer, Seaside Area, Corral de Tierra Area, and the Paso Robles Area. The Paso Robles Area will be discussed in the subsequent section. The major land uses in this region include agriculture, rangeland, forest, and urban development. The largest urban areas are the cities of Santa Cruz, Watsonville, Monterey, Salinas, and King City.

The Pajaro Valley basin lies on the border between Santa Cruz, Monterey, and San Benito Counties and is nestled between Monterey Bay to the west and the San Andreas Fault to the east. The San Andreas Fault separates the basin from the other groundwater basins within the Pajaro Valley Watershed. The basin is recharged through direct percolation of rainfall and irrigation water, and through stream flow seepage from the Pajaro River and its tributaries.

The Salinas Valley groundwater basin is located in Monterey County and stretches from Monterey Bay southeast for approximately 75 miles to the headwaters of the Salinas River, overlaying approximately 620 square miles. Groundwater generally flows northeast, towards Monterey Bay. Recharge to the lower aquifers (180/400 foot aquifer, Langley Area, East Side Aquifer, Seaside Area, Corral de Tierra Area) is largely from percolation from the Salinas River and its tributaries in the Forebay area.

All eight of the basins in this region were identified as “high” or “medium” priority in the CASGEM Groundwater Basin Prioritization final results released June 10, 2014 (Table 2). The East Side Aquifer is the top ranked groundwater subbasin in the state.

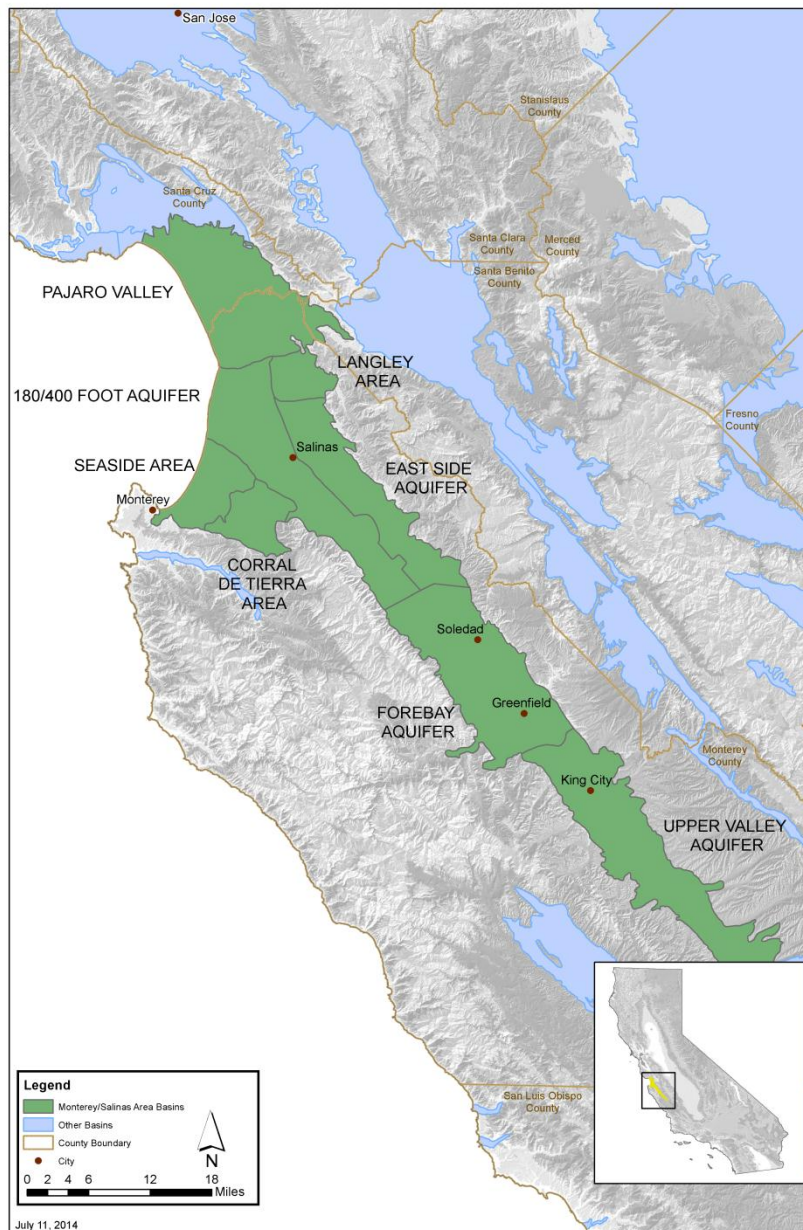
Table 2 - Groundwater Basins in the Monterey / Salinas Area

Basin Number	Basin / Subbasin Name	Basin Area		Overlying Population (2010)	CASGEM Groundwater Basin Ranking		
		Acres	Sq. Mile		Rank	Score	Basin Priority
3-2	PAJARO VALLEY	88,062	137.6	114,282	8	24.8	High
3-4.01	SALINAS VALLEY - 180/400 FOOT AQUIFER	84,321	131.8	55,740	12	24.0	High
3-4.02	SALINAS VALLEY - EAST SIDE AQUIFER	57,452	89.8	128,646	1	27.0	High
3-4.04	SALINAS VALLEY - FOREBAY AQUIFER	94,025	146.9	43,867	90	17.3	Medium
3-4.05	SALINAS VALLEY - UPPER VALLEY AQUIFER	98,164	153.4	15,862	108	15.5	Medium
3-4.08	SALINAS VALLEY - SEASIDE AREA	25,903	40.5	65,899	48	20.8	Medium
3-4.09	SALINAS VALLEY - LANGLEY AREA	15,344	24.0	9,833	73	18.8	Medium
3-4.10	SALINAS VALLEY - CORRAL DE TIERRA AREA	22,274	34.8	7,831	116	15.0	Medium

Source: California Statewide Groundwater Elevation Monitoring (CASGEM) Groundwater Basin Prioritization

http://www.water.ca.gov/groundwater/casgem/pdfs/lists/StatewidePriority_05262014.pdf

Figure 2 - Groundwater Basins in the Monterey and Salinas Valley Area



Source: Figure provided by RMC Water and Environment.

Groundwater Level Trends, Seawater Intrusion, and Groundwater Quality

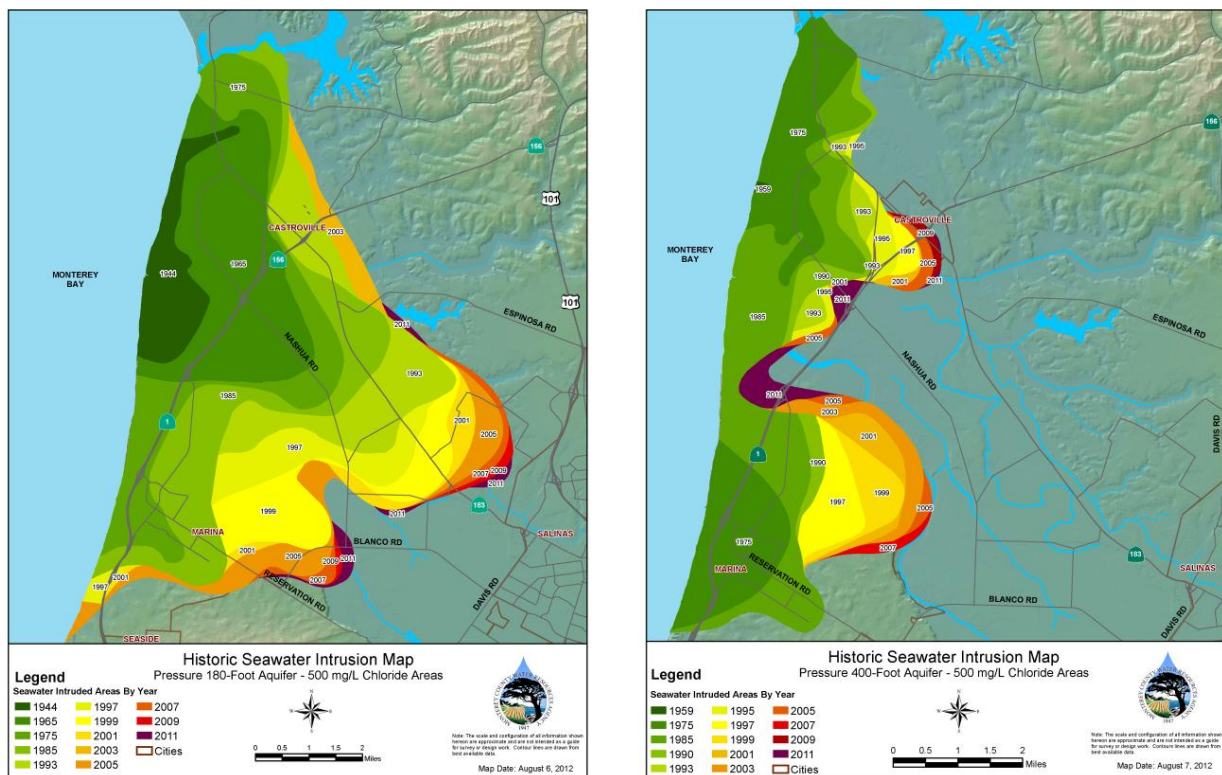
The Pajaro Valley basin and the Salinas Valley basin are in a state of long-term overdraft, resulting in falling groundwater levels and regional seawater intrusion. Groundwater levels in this region have dropped from historic levels and are below sea-level elevation in much of the region. In recent years, groundwater levels in the Salinas Valley appear relatively stable, because seawater has replaced the

freshwater groundwater that has been pumped out. This leaves water levels stable, but results in degraded water quality.

Lowered groundwater levels and the resulting seawater intrusion have reduced groundwater storage in the region. The Pajaro Valley basin lost approximately 300,000 acre-feet of groundwater storage from 1964 to 1997, with approximately 200,000 acre-feet of loss due to saltwater intrusion and 100,000 acre-feet due to chronic overdraft. In 1980, DWR identified critical conditions of groundwater overdraft in the Pajaro Valley. Overdraft conditions have worsened since that time, with pumping rates nearly twice the sustainable yield of the groundwater basin (Levy and Christian-Smith, 2011).

Seawater intrusion began in the Salinas Valley by the 1930s. Since that time, seawater intrusion has continued and now extends more than five miles inland. The Monterey County Flood Control and Water Conservation District built Nacimiento Dam in 1957 and an Antonio Dam in 1965 to provide flood control and to accelerate groundwater recharge to mitigate seawater intrusion. In April 1998, the Monterey County Water Recycling Projects started delivering recycled water for irrigation in lieu of groundwater pumping, effectively slowing the seawater intrusion rate (MCWRA, 2006). As shown in Figure 3, these management actions have been effective in reducing the rate of seawater intrusion.

Figure 3 - Historic Seawater Intrusion Map for the Salinas Valley 180-ft and 400-ft Aquifers

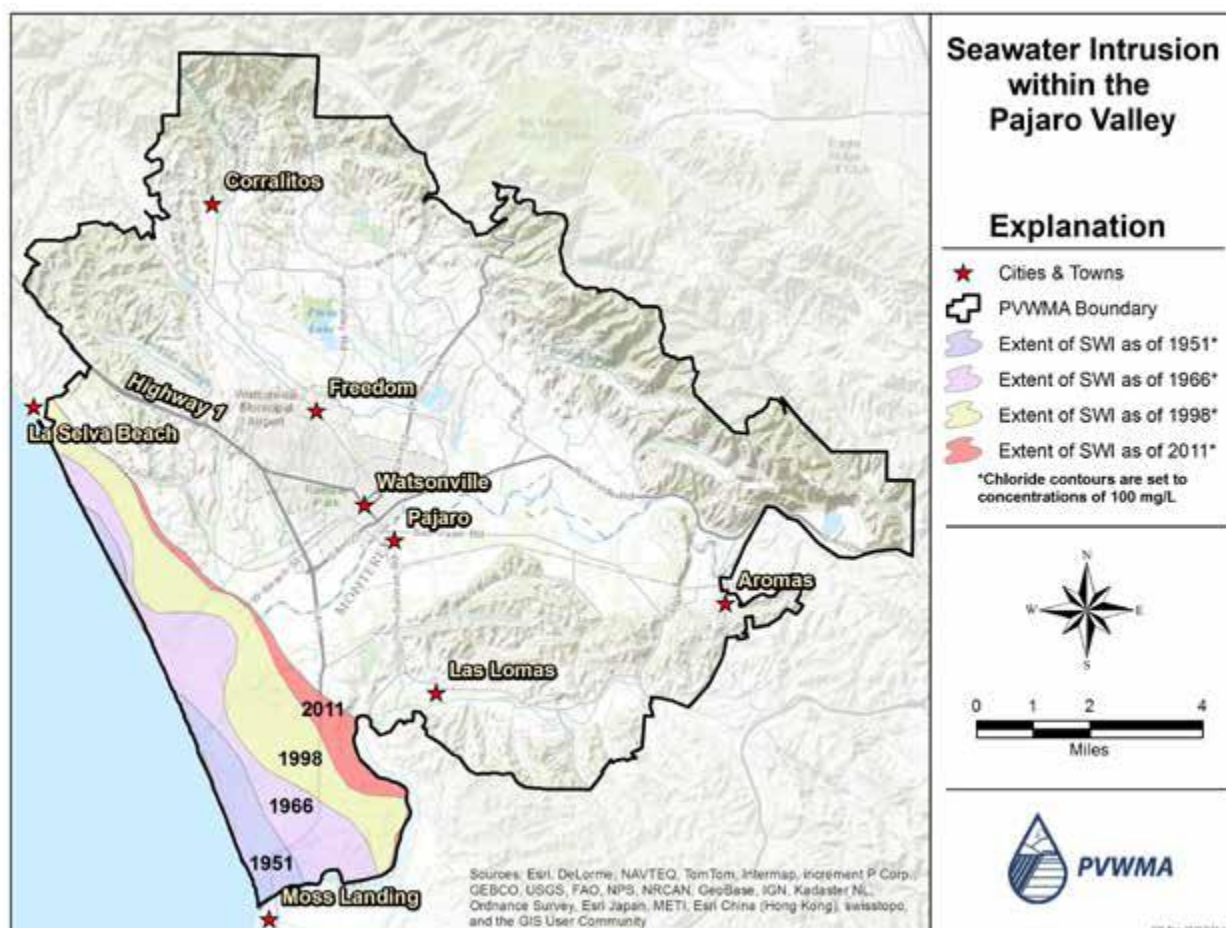


Source: Monterey County Water Resources Agency
<http://www.mcwra.co.monterey.ca.us/SVWP/01swi180.pdf>

<http://www.mcwra.co.monterey.ca.us/SVWP/01swi400.pdf>

Seawater intrusion was first documented in the Pajaro Valley basin in 1953, and has continued since that time. Because the Pajaro Valley basin is in severe overdraft, groundwater levels have dropped below sea-level, allowing seawater to move into the aquifer. Seawater intrusion in the Pajaro Valley basin has been observed up to three miles inland, as shown in Figure 4 (PVWMA, 2014B). The current seawater intrusion rate in the Pajaro Valley is estimated to be 100 to 250 feet per year, and its effects already extend several miles inland (PVWMA, 2014A).

Figure 4 – Historic Seawater Intrusion Map for the Pajaro Valley



Source: Pajaro Valley Water Management Agency (PVWMA). Basin Management Plan Update – Final. Prepared by Carollo Engineers. February 2014.

In addition to salinity issues, several groundwater contaminants are present in these aquifers. The basin was part of the California Groundwater Ambient Monitoring and Assessment (GAMA) program, which investigated groundwater quality from July through October 2005. The study found high total dissolved solids concentrations in about 9% of the primary aquifers in the Monterey and Salinas area. In addition, 32% of the primary aquifers had moderate TDS concentrations. Iron and manganese, naturally occurring elements, were present in high concentrations in about 21% of the primary aquifers and in moderate concentrations in 11% of the aquifers. One or more trace elements were detected in high

concentrations in about 6% of the region, with arsenic, boron and molybdenum being the most common.

The primary constituent of concern in the basin is nitrate. High nitrate levels threaten human health, especially for infants. In the GAMA study, nitrate was present at high concentrations in about 8% of the primary aquifers of the region. High nitrate concentrations are present in shallower wells in both agricultural and urban areas throughout the region. Nitrate seeps into groundwater from nitrate-rich fertilizers or animal waste that is applied to the surface, as well as from septic systems. Nitrate contamination present in groundwater resources today likely came from sources applied years ago, so nitrate problems are likely to persist well into the future.

Groundwater Management Activities and Future Conditions

Unlike most areas in the state, the Pajaro Valley basin and the Salinas Valley basins are managed by special act groundwater districts: the Pajaro Valley Water Management Agency and the Monterey County Water Resources Agency.

The Pajaro Valley Water Management Agency was formed in 1984 to help alleviate saltwater intrusion and to slow or reduce groundwater overdraft in the region. PVWMA provides oversight and planning for the Pajaro Valley basin. It has developed basin management plans to guide all of PVWMA's major projects and programs. The neighboring water districts, Soquel Creek Water District and Central Water District, included the Pajaro Valley basin in their 2007 groundwater management plan for the Soquel-Aptos Area.

The formation of a special act district for the Salinas Valley basins was prompted by early concerns about seawater intrusion and flooding problems throughout the region. The Monterey County Flood Control and Water Conservation District as formed in 1947 and became the Monterey County Water Resources Agency (MCWRA) in 1991. MCWRA developed and adopted a groundwater management plan in 2006 that covers the Salinas Valley basins.

The Seaside Area basin was adjudicated in 2006. The ruling requires Cal-Am Water Company (the major local water supplier) to reduce its groundwater pumping (DWR, 2014).

Throughout the region, there are a number of conjunctive use and groundwater management programs. On June 25, 2014, the Monterey County Water Resources Agency issued a Notice of Preparation for the Salinas Valley Water Project, Phase II. This project is intended to capture and divert surface water from the Salinas River for use within the Salinas Valley area and offset pumping from the Salinas Valley groundwater basin. This project is being designed with the specific objective of combating seawater intrusion in Monterey County.

In April 2014, the Pajaro Valley Water Management Agency Board of Directors adopted a Basin Management Plan update. The plan proposes six projects and an aggressive conservation program that will reduce groundwater over pumping by 90% and essentially halt seawater intrusion into the Pajaro Valley Aquifer (PVWMA, 2014B).

Paso Robles Area

The Paso Robles groundwater subbasin is located in northern San Luis Obispo County and southern Monterey County (Figure 5). In DWR) Bulletin 118, it is defined as a subbasin of the Salinas Valley groundwater basin. It is over 900 square miles and ranges from the Garden Farms area south of Atascadero to San Ardo in Monterey County, and from Highway 101 corridor east to Shandon. It was classified as “high” priority in the CASGEM basin prioritization process.

Over the past 30 years, the amount of irrigated agriculture, especially vineyards, and low-density residential development has increased across the basin, increasing water demand and reducing the flexibility or “hardening” that demand (Water in the West, 2014). Agriculture is the largest water user in the basin, using approximately 67% of the water supply; municipal water use makes up 18%, rural domestic uses 13% and small commercial systems use 3% (GEI, 2011). There are over 8,000 wells in the Paso Robles basin (San Luis Obispo County, 2011).

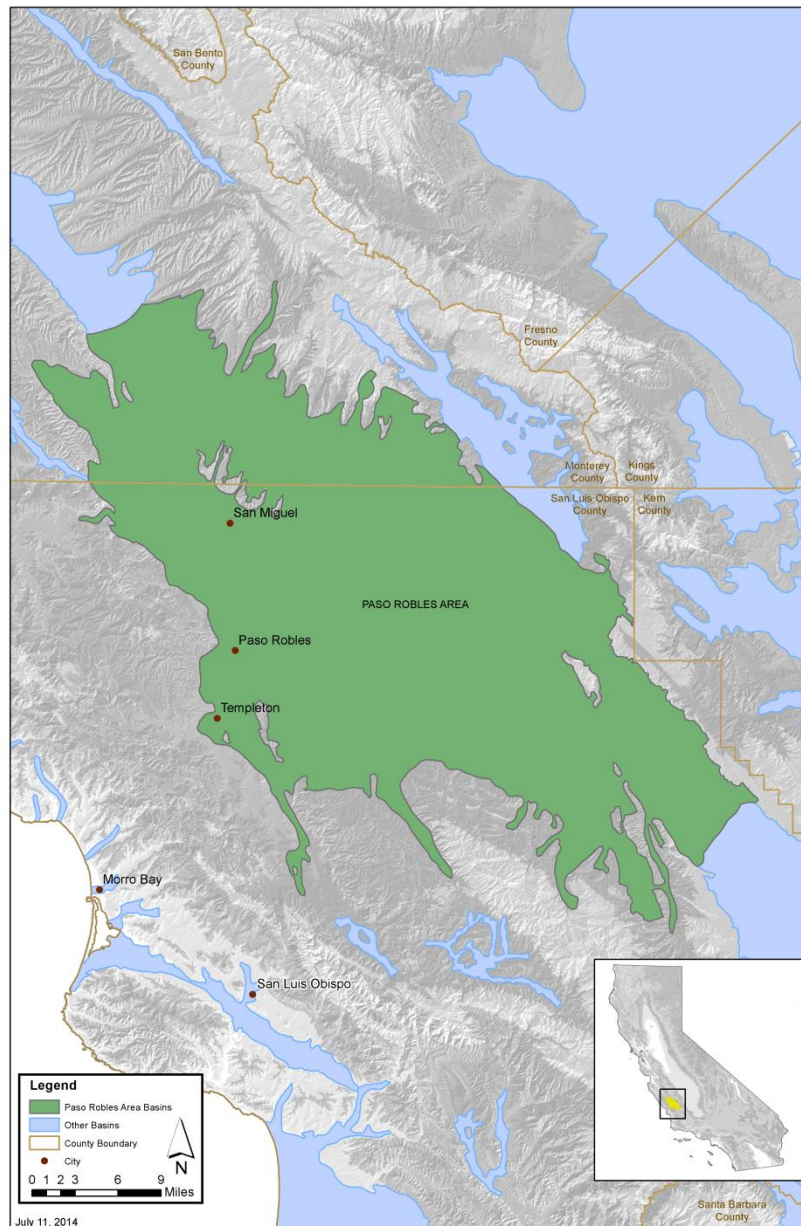
Table 3 - Groundwater Basins in the Paso Robles Area

Basin Number	Basin / Subbasin Name	Basin Area		Overlying Population (2010)	CASGEM Groundwater Basin Ranking		
		Acres	Sq. Mile		Rank	Score	Basin Priority
3-4.06	SALINAS VALLEY - PASO ROBLES AREA	597,241	933.2	56,077	14	23.3	High

Source: California Statewide Groundwater Elevation Monitoring (CASGEM) Groundwater Basin Prioritization

http://www.water.ca.gov/groundwater/casgem/pdfs/lists/StatewidePriority_05262014.pdf

Figure 5 - Groundwater Basins in the Paso Robles Area



Source: Figure provided by RMC Water and Environment.

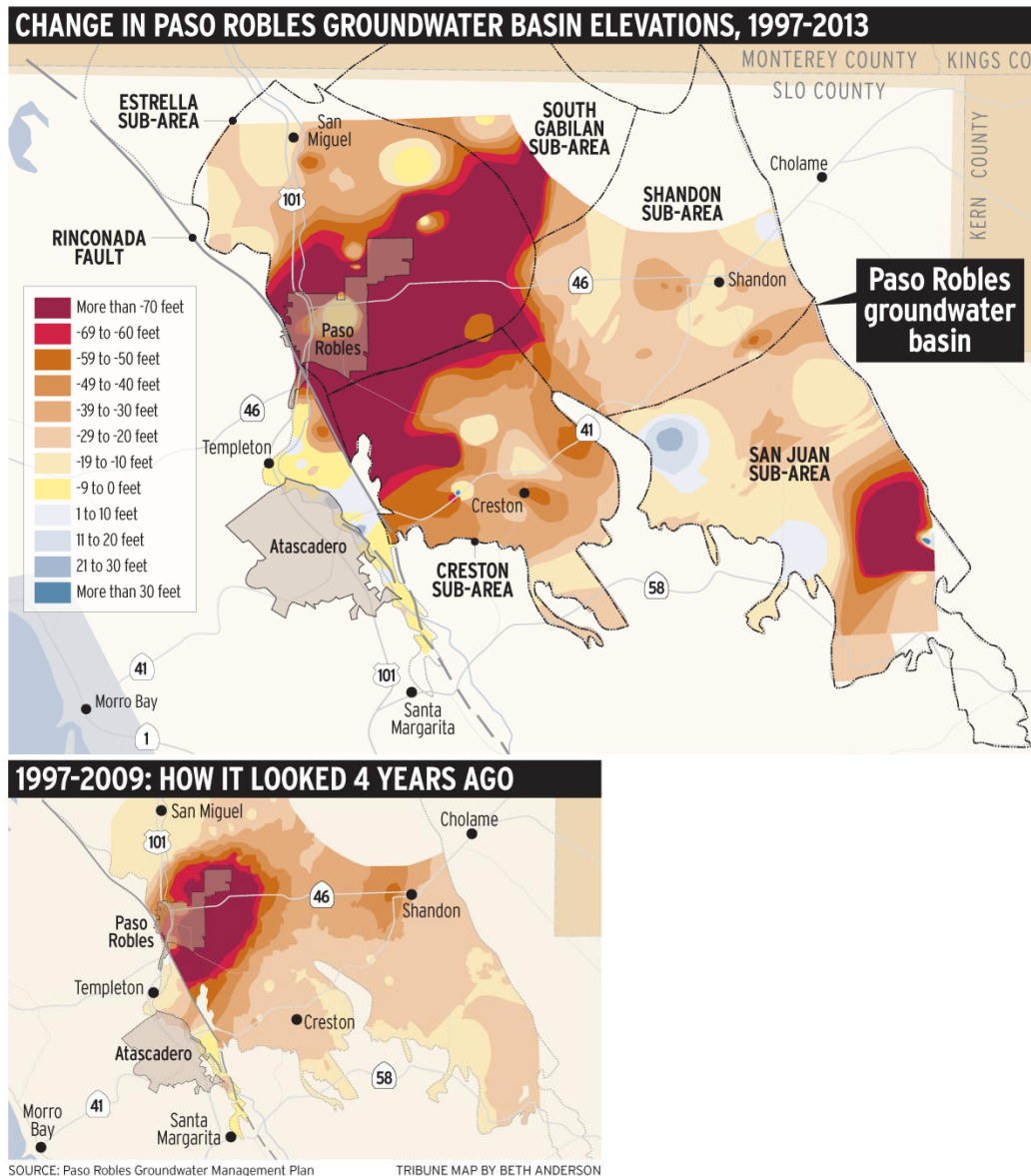
Groundwater Level Trends, Seawater Intrusion, and Groundwater Quality

Groundwater levels have been dropping rapidly in the Paso Robles subbasin in recent years. Figure 6 illustrates the change in groundwater levels from 1997-2009 and again from 1997-2013. In 2009, groundwater levels had dropped by more than 70 feet since 1997 in the western portion of the basin near the City of Paso Robles. Just four years later, groundwater levels had dramatically dropped across the rest of the basin. This acceleration in groundwater level decline is a result of several dry years and an increase in groundwater pumping. Declining water levels have resulted in water quality problems and caused many wells to go dry.

A 2005 study established the perennial yield of the basin, the amount of water that can be withdrawn each year indefinitely without causing depletion of the basin, to be 97,700 acre-feet per year. In 2011 the County Board of Supervisors concluded that the basin was at or rapidly approaching that limit (San Luis Obispo County, 2011). In general, groundwater quality is good within the basin, but there are areas of contamination. Concerns include elevated levels of total dissolved solids, chloride, and nitrates, possibly due to wastewater discharges, agricultural practices, irrigation with recycled water, or pumping or upwelling from deeper aquifers (GEI, 2011). Because this is an inland basin, it is not threatened by seawater intrusion.

Four areas of subsidence have been noted in the Paso Robles region to occur during a six month period in 1997. In the area of maximum displacement, northeast of Paso Robles, land subsided 2 cm (0.8in), likely due to concentrated groundwater pumping during that same period. Although it has not been quantified, the recent rapid groundwater level declines may have triggered additional subsidence in this area (Borchers, et al., 2014).

Figure 6 – Groundwater Level Elevation Changes in the Paso Robles Groundwater Basin 1997- 2009 and 1997-2013



Source: San Luis Obispo County Department of Public Works and the San Luis Obispo Tribune.

Groundwater Management Activities and Future Conditions

Over the past decade the San Luis Obispo County Flood Control and Water Conservation District and the City of Paso Robles have worked together with local stakeholders to take a more comprehensive approach to groundwater management in the basin. In 2011 they published the *Paso Robles Groundwater Basin Management Plan*. The plan addresses groundwater conditions, identifies current and future threats, and proposes actions to protect the groundwater basin. However, without local authority to manage and limit groundwater pumping, the effectiveness of the plan is limited.

As discussed above, dry years and increased groundwater pumping have caused a dramatic decrease in groundwater levels since 2009. In July 2013, over 100 rural property owners complained to the San Luis

Obispo County Board of Supervisors that their wells were running dry (Water in the West, 2014). On August 27, 2013, the San Luis Obispo County Board of Supervisors adopted the “Paso Robles Groundwater Basin Urgency Ordinance” that required any new development or new irrigated agriculture to offset water use by a 1:1 ratio. This temporary action does not address the larger issue of groundwater overdraft, but attempts to maintain the current level of overdraft for the duration of the ordinance. A long-term solution will require an overall decrease in groundwater pumping or an increase in groundwater recharge.

Recently, there have been efforts to develop a new water district to coordinate groundwater management efforts and secure a sustainable groundwater supply in the region. However, the two local water groups that proposed forming the management district have withdrawn their support for the bill in its current form due to debates over representation on the governing board. It is unclear whether the bill will ultimately have local support. Even so, there is a great deal of local interest in finding a long-term solution to ensure the sustainability of the Paso Robles groundwater basin.

Santa Barbara Area

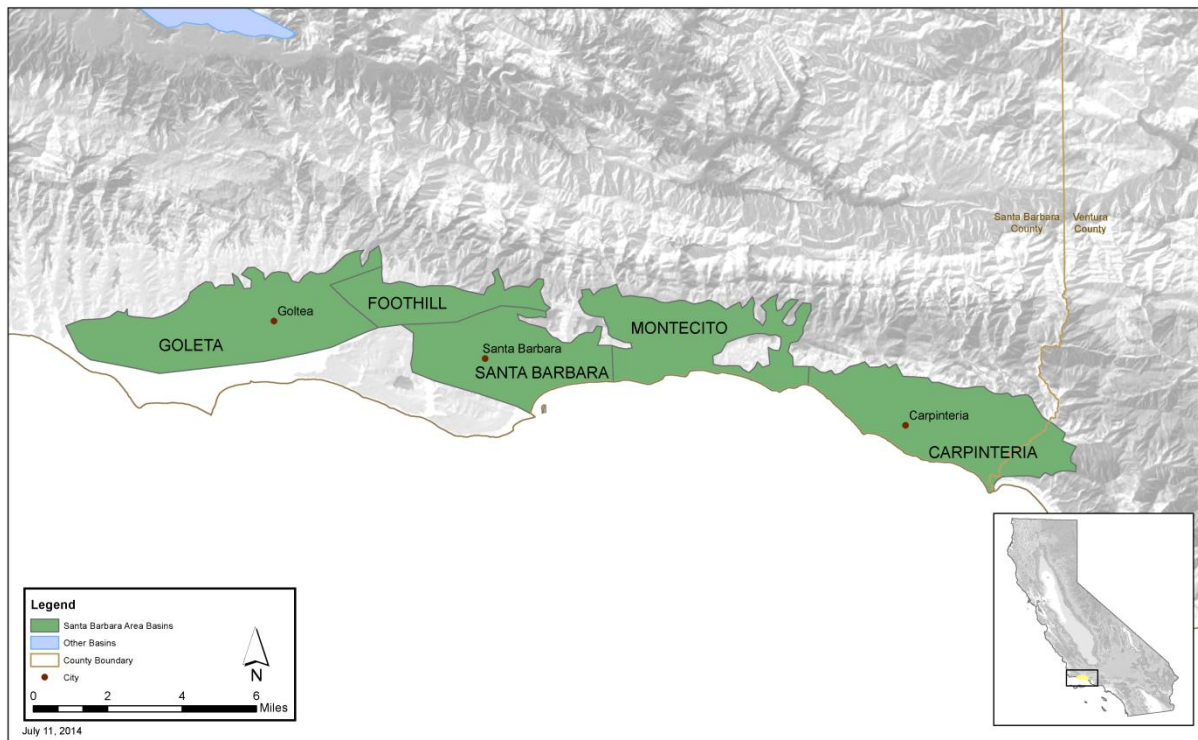
There are five groundwater basins in the South Coast portion of the Santa Barbara region, all located within the County of Santa Barbara. Together, the Goleta, Santa Barbara, Carpinteria, Montecito and Foothill groundwater basins (Figure 7) underlie approximately 50 square miles. They are located between the Santa Ynez Mountains and the Pacific Ocean. Major land use in Santa Barbara County includes agricultural preserves (land zoned for 100-acre or greater lot size) or other agriculturally zoned land. Urban areas make up less than 5% of the county. The major urban areas of this region include Goleta, the City of Santa Barbara and Carpinteria.

Of the five basins in this area, the Goleta basin was assigned “Medium” priority through the CASGEM prioritization process, whereas the other four basins are “Very Low” priority (Table 4).

Table 4 - Groundwater Basins in the Santa Barbara Area

Basin Number	Basin / Subbasin Name	Basin Area		Overlying Population (2010)	CASGEM Groundwater Basin Ranking		
		Acres	Sq. Mile		Rank	Score	Basin Priority
3-16	GOLETA	9,229	14.4	47,252	74	18.8	Medium
3-17	SANTA BARBARA	6,173	9.6	63,966	353	0.0	Very Low
3-18	CARPINTERIA	8,140	12.7	14,561	316	0.0	Very Low
3-49	MONTECITO	6,286	9.8	9,885	352	0.0	Very Low
3-53	FOOTHILL	3,123	4.9	17,543	418	0.0	Very Low

Source: California Statewide Groundwater Elevation Monitoring (CASGEM) Groundwater Basin Prioritization
http://www.water.ca.gov/groundwater/casgem/pdfs/lists/StatewidePriority_05262014.pdf

Figure 7 - Groundwater Basins in the Santa Barbara Area

Source: Figure provided by RMC Water and Environment.

Groundwater Level Trends, Seawater Intrusion, and Groundwater Quality

Groundwater trends in the Santa Barbara South Coast vary by groundwater basin. Across most of the Carpinteria Groundwater basin, water levels are above sea level. Groundwater levels fall below sea level in the central portion of the basin and near the coast. Although no seawater intrusion has been documented in this subbasin to date, the presence of below sea-level groundwater levels along the coast create a condition that could allow seawater intrusion in the future. Recently, groundwater levels have dropped 15 to 25 feet in portions of the basin, and as much as 40 feet in the far eastern portion of the basin. Based on current pumping rates and estimates of “safe yield” and “operational yield” the basin is not believed to be in a state of overdraft (Fugro, 2014).

Water levels in the Montecito Groundwater Basin have been relatively stable, but water demand has been steadily increasing since 1991.

The Santa Barbara basin has had more fluctuation in water levels. In the 1970s groundwater levels dropped as much as 100 feet, which led to some sea water intrusion. However, the City of Santa Barbara is currently managing the groundwater basin as a storage reservoir for conjunctive use, thereby reducing groundwater pumping in normal years. Reducing pumping and implementing a groundwater injection program has effectively reversed the seawater intrusion trend in this area (Santa Barbara County Public Works Department, 2012).

The Foothill Basin experienced significant drops in water levels prior in the 1950s but has since recovered due to the introduction of other water sources. The basin is actively managed by the City of

Santa Barbara and the La Cumbre Mutual Water Company and is not considered to be in overdraft (Santa Barbara County Public Works Department, 2012).

The Goleta basin has been in a historic state of overdraft. This led to court action in the basin and the Wright Judgment in 1989 adjudicated the water resources of the basin. Since that time, groundwater levels have recovered.

Seawater intrusion is no longer a significant issue in this region. Of the five highlighted basins, only the Santa Barbara basin has experienced historic seawater intrusion, and this trend has largely been reversed. Overall, groundwater quality is good throughout the region, although some wells in this region show elevated levels of total dissolved solids and other constituents.

Groundwater Management Activities and Future Conditions

Several local entities have prepared and adopted groundwater management plans for these basins, as listed in Table 5. In addition, the Santa Barbara County Public Works Department released the *Santa Barbara County 2011 Groundwater Report* in May 2012.

Table 5 - Groundwater Management Plans in the Santa Barbara Area

Groundwater Management Plan Status			
Basin	Public Agency Participants ¹	Status	Year
Carpinteria	Carpinteria Valley WD	Plan Adopted	1996
Foothill	City of Santa Barbara	Plan Adopted	1994
Goleta	Goleta WD	Court Action ²	1989
Montecito	Montecito WD	Plan Adopted	1998
Santa Barbara	City of Santa Barbara	Plan Adopted	1994

Notes:

1) Other participants include private water companies and overlying property owners

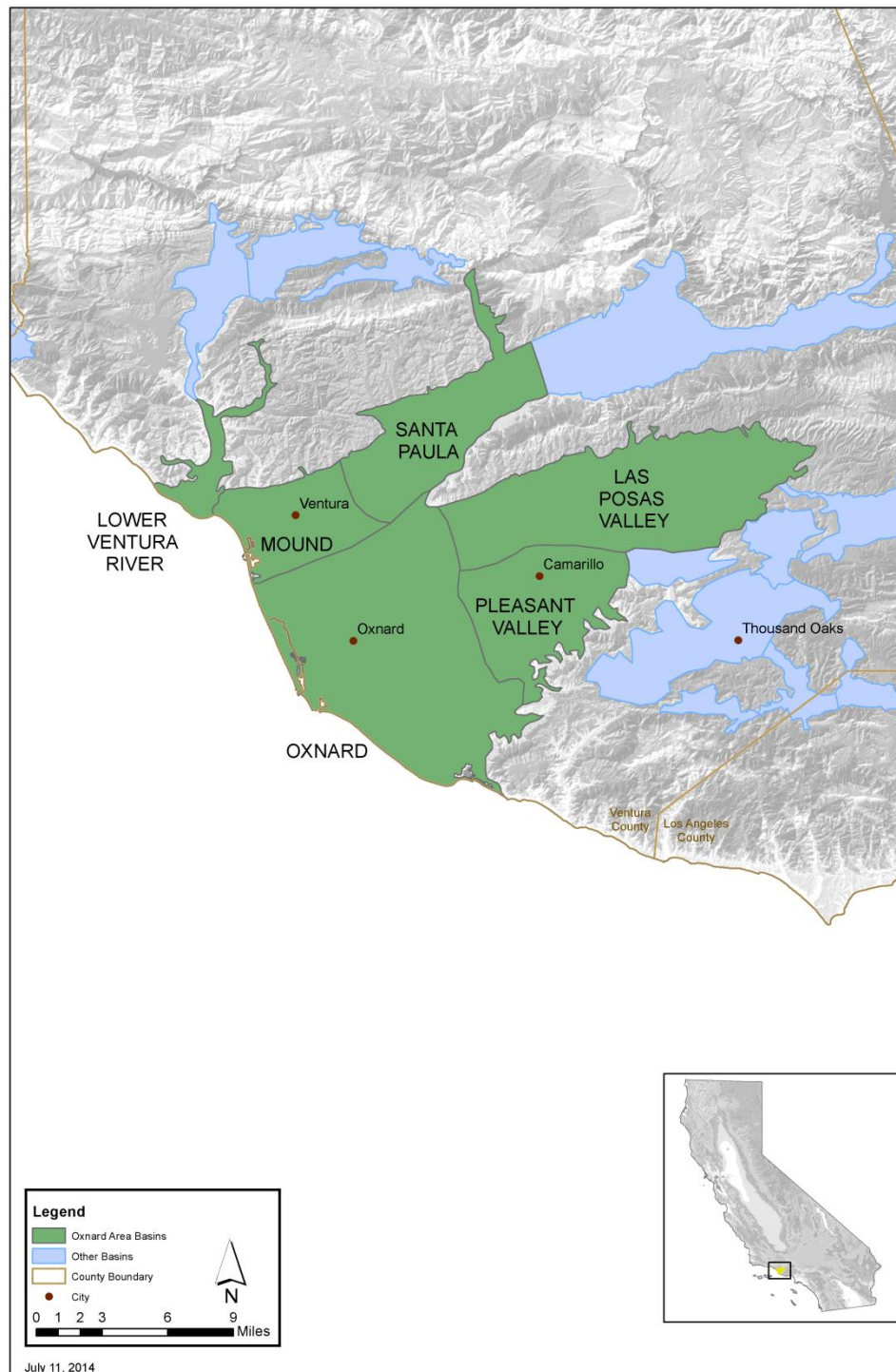
2) The "Wright Suit" Settlement stipulates management actions in the North and Central Subbasins

Source: Table 3 from Santa Barbara County 2011 Groundwater Report (Santa Barbara Public Works Department, 2012)

Oxnard Plain Area

The Oxnard Plain area consists of six groundwater basins: Lower Ventura River, Mound, Santa Paula, Oxnard, Las Posas Valley, and Pleasant Valley, underlying approximately 260 square miles (Table 6 and Figure 8). The basins are located in Ventura County and underlie east-west trending valleys with general groundwater flow to the southwest, towards the Pacific Ocean. These basins generally contain two major aquifer systems: the Upper Aquifer System and the Lower Aquifer System. The primary source of recharge for aquifers underlying the Oxnard plain is the Oxnard Plain Forebay basin, located in the Northwest portion of the Oxnard basin. This area is recharged from percolation of Santa Clara River flows, artificial recharge from United Water Conservation District's spreading grounds at Satcoy and El Rio, agricultural and household irrigation return flows, percolation of rainfall, and some underflow from adjacent basins (FCGMA, 2007). Five of the six basins highlighted for this region were identified as "high" or "medium" priority in the CASGEM basin prioritization process. The Santa Paula basin was adjudicated by the court in 1996.

Figure 8 - Groundwater Basins in the Oxnard Area



Source: Figure provided by RMC Water and Environment.

Table 6 - Groundwater Basins in the Oxnard Area

Basin Number	Basin / Subbasin Name	Basin Area		Overlying Population (2010)	CASGEM Groundwater Basin Ranking		
		Acres	Sq. Mile		Rank	Score	Basin Priority
4-3.02	VENTURA RIVER VALLEY - LOWER VENTURA RIVER	5,312	8.3	15,920	369	0.0	Very Low
4-4.02	SANTA CLARA RIVER VALLEY - OXNARD	58,200	90.9	235,973	2	26.8	High
4-4.03	SANTA CLARA RIVER VALLEY - MOUND	14,846	23.2	77,886	94	17.3	Medium
4-4.04	SANTA CLARA RIVER VALLEY - SANTA PAULA	22,899	35.8	46,816	52	20.5	Medium
4-6	PLEASANT VALLEY	21,654	33.8	69,392	25	22.5	High
4-8	LAS POSAS VALLEY	42,353	66.2	39,835	31	22.3	High

Source: California Statewide Groundwater Elevation Monitoring (CASGEM) Groundwater Basin Prioritization

http://www.water.ca.gov/groundwater/casgem/pdfs/lists/StatewidePriority_05262014.pdf

Groundwater Level Trends, Seawater Intrusion, and Groundwater Quality

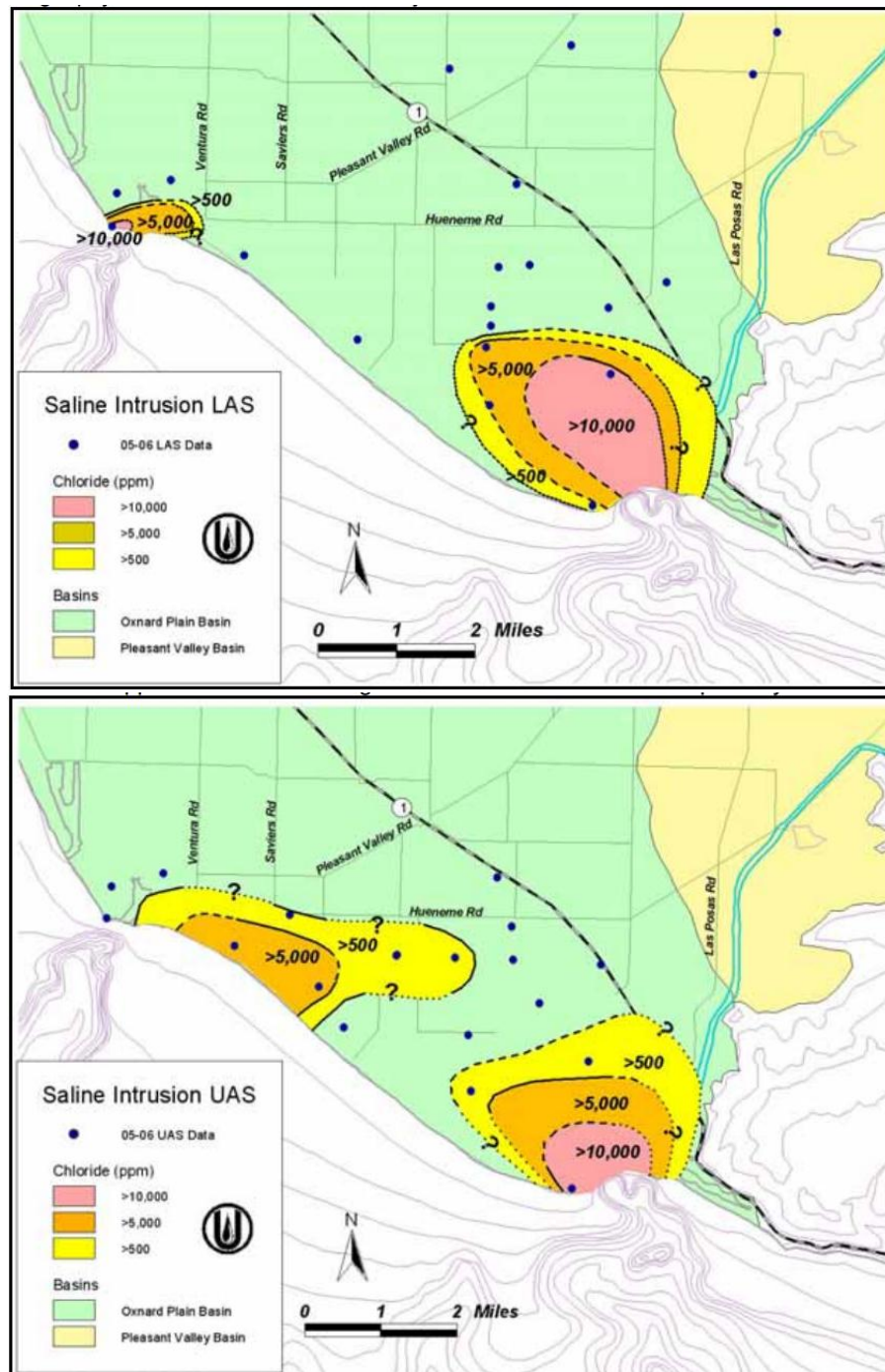
Groundwater levels throughout most of the region have been relatively stable or have shown an increasing trend. In the coastal regions, this stability may be misleading as it may be largely due to seawater intrusion since groundwater levels are below sea level throughout much of this region. Groundwater levels in the Las Posas Valley show a strong upward trend where they have risen more than 100 feet over the past 40 years as a result of increased recharge from percolation beneath the Arroyo Las Posas. Flows through Arroyo Las Posas have increased due to increasing discharges from the Moorpark and Simi Valley wastewater treatment plants and dewatering wells in Simi Valley.

Seawater intrusion was first identified in the region near Port Hueneme in the 1930s and was widespread as early as the 1940s. At that time, groundwater levels in the Oxnard Plain basin dropped below sea level drawing seawater into the basin and causing rapidly rising chloride concentrations. Seawater intrusion also occurred in the Point Mugu aquifer and later spread to the Lower Aquifer System when groundwater levels in that region dropped below sea level in the late 1950s (Figure 9). The initial groundwater management plan prepared by the Fox County Groundwater Management Agency focused on containing seawater intrusion within the south Oxnard Plain basin. Since that time, management changes, including pumping reductions, shifting of pumping locations, construction of the Freeman Diversion, and the operation of the Pumping Trough and Pleasant Valley pipeline systems have significantly reduced seawater intrusion. However, seawater intrusion conditions persist, and in the Point Mugu area chlorides remain at high concentrations.

While salinity issues, including elevated chlorides and total dissolved solids, are the primary water quality concern through the region, other constituents of concern include nitrates, iron, manganese and sulfate. Nitrate contamination from septic systems and agricultural fertilizer application is widespread.

In addition to causing seawater intrusion, over-pumping also caused irreversible land subsidence in this region. Subsidence of 0.8 meters (2.6 feet) was measured in the valley of Calleguas Creek north west of Point Magu, 0.9m (3 feet), in the southern part of the Oxnard Plain and 1.5 m (5 feet) in the Las Posas Valley subbasin (Borchers, et al., 2014).

Figure 9 - Seawater Intrusion in the Upper and Lower Aquifer Systems of the Oxnard Plain in 2005-2006



Source: (FCGMA, 2007)

Groundwater Management Activities and Future Conditions

The Fox Canyon Groundwater Management Agency (FCGMA) was established in 1982 and manages the Oxnard, Pleasant Valley and Las Posas Valley basins within this focal region. FCGMA adopted its first groundwater management plan in 1987 and has updated it periodically since that time. The most recent update was released in May 2007. FCGMA coordinates management of the basin with other local entities. Table 6 summarizes the management agencies overseeing these Ventura County Basins.

Table 6 - Summary of Management Agencies in the Ventura County Basins

Agency	Role
Fox Canyon Groundwater Management Agency (GMA)	Establishes policy Sets pumping allocations, phased reductions, water level and water quality criteria through its Groundwater Management Plan
United Water Conservation District (UWCD)	Operates river diversions, spreading basins, in-lieu pipelines, and reservoir to capture winter runoff. Conducts seawater intrusion monitoring, area-wide monitoring database management, area-wide studies and reporting, maintenance of area-wide groundwater model, and technical analyses for GMA
Calleguas Municipal Water District (Calleguas MWD)	Operates the Las Posas ASR project. Performs duties specified in the East Las Posas Basin Management Plan (included within the GMA Groundwater Management Plan) with local pumpers in the Las Posas Basin Users Group. Performs regional water supply planning with United Water Conservation District.
Ventura County Water Resources Dept.	Issues well permits and ordinances (including which aquifers to pump). Shares monitoring responsibilities with UWCD.
State Water Resources Control Board	Controls conditions for the Oxnard Forebay Basin: when groundwater levels fall below a specified level, all diverted surface waters must go to spreading
Las Posas Basin Users Group	Forum for discussion of issues related to Las Posas ASR Project

Source: (Metropolitan Water District of Southern California, 2007)

Conclusions and Recommendations

The Central Coast is critically dependent upon groundwater. Because the region is geographically isolated, it relies nearly exclusively on local water resources and cannot easily bring in new surface water that is more readily available to other areas of the state. As California confronts one of the worst droughts in recorded history, it is critical to consider ways to protect the Central Coast's invaluable groundwater resource for the present and future health of its farms, cities, and environment.

As described above, much work has been done to address the current threats to groundwater resources in this region, but it is not enough. Serious threats to the Central Coast's groundwater resources remain. Because groundwater is a common pool resource, effective and equitable groundwater management is difficult. Local entities lack the authority to control groundwater withdrawals which limits their ability to effectively manage this resource. The lack of regulation has led to a tragedy of the commons, resulting in a "race to the bottom," pitting neighbors against each other and causing risks of permanent damage from saltwater intrusion. Without statewide oversight and assistance, there is limited ability to coordinate between groundwater basins, limiting the ability to co-manage hydrologically connected basins or deal with associated conflicts. A broader and more consistent management framework will also enable basins to learn from similar situations and identify solutions that will be effective both locally and regionally.

A new state policy with the following components would improve the effectiveness of groundwater planning and support sustainable management of groundwater resources along California's Central Coast.

- **Establish a statewide policy of sustainability.** While the geology, economics, environment, and social conditions of each groundwater subbasin are different, it is important to have an overarching policy and set of standards for groundwater management. It should be the policy of the state that groundwater be managed sustainably and that all locally developed groundwater management plans describe their specific objectives for each subbasin along with the steps that they will take to achieve them.
- **Organize and empower local groundwater agencies.** Each medium and high priority groundwater subbasin, as defined by DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) groundwater prioritization framework, should elect or form local groundwater sustainability agencies (GSA) through collaboration among existing counties, cities, water agencies and interested citizens. This may be through development of a Joint Powers Authority or through the formation of a new separate entity. GSAs should be granted the necessary authorities to sustainably manage the basin, including the ability to limit pumping, require monitoring, and collect fees.
- **Require the development and implementation of groundwater sustainability plans.** The GSAs within each medium and high priority groundwater basins should be required to develop a groundwater sustainability plan with specific measurable objectives that achieve sustainability on a realistic and defined schedule.

- **Provide technical guidance and financial support to local agencies.** State agencies should be encouraged to provide guidance and assistance to local GSAs such as expanded guidelines that could assist in development or implementation of local plans
- **Empower the State to oversee implementation.** A new state policy should allow the Department of Water Resources and State Water Resources Control Board to oversee local groundwater management activities and intervene only when a local area is unable or unwilling to sustainably manage the basin. The state agencies should plan to return control to locals as soon as is possible.

About the Author

Julie Nico Martin is an independent consultant specializing in water and natural resource issues. She holds a master's degree in environmental engineering from Stanford University and bachelor's degrees in hydrology and economics from UC Davis. She has over 10 years of experience in California water issues working with governmental, non-profit, university, and private sector organizations. Her work has included groundwater management, regional water management planning, environmental compliance, land conservation, and ocean conservation.

References

Bachman, Steve. (2010). *Groundwater Management Plan Goleta Groundwater Basin*. Goleta Water District and La Cumbre Mutual Water Company. Retrieved July 6, 2014, from http://www.goletawater.com/assets/documents/groundwater-management/Groundwater_Management_Plan_Final_05-11-10.pdf

Borchers, J.W., V. Kretsinger Grabert, M. Carpenter, B. Dalgish, and D. Cannon. (2014). *Land Subsidence from Groundwater Use in California*. Prepared by Luhdorff & Scalmanini Consulting Engineers.

California Department of Water Resources. (2003). *California's Groundwater Bulletin 118 – Update 2003*. Retrieved July 8, 2014, from <http://www.water.ca.gov/groundwater/bulletin118/bulletin118update2003.cfm>

California Department of Water Resources. (2014) *California Water Plan Update 2013 – Public Review Draft*. Retrieved July 9, 2014, from <http://www.waterplan.water.ca.gov/cwpu2013/prd/index.cfm>

California Water Foundation. (2014). *Recommendations for Sustainable Groundwater Management: Developed Through a Stakeholder Dialogue*.

Fox Canyon Groundwater Management Agency. (2007). *2007 Update to the Fox Canyon Groundwater Management Agency Groundwater Management Plan*.

Fugro Consultants, Inc. (2014). *Carpinteria Groundwater Basin, Annual Report for 2013, Draft*. Prepared for the Carpinteria Valley Water District.

GEI Consultants, Inc. (2011). *Paso Robles Groundwater Basin Management Plan*. Prepared for San Luis Obispo County Flood Control and Water Conservation District and the City of Paso Robles.

Harter T, Lund J. (2012). *Addressing Nitrate in California's Drinking Water: Executive Summary* Center for Watershed Sciences, University of California, Davis.

Kulongoski, Justin T. and Belitz, Kenneth. *Groundwater quality in the Monterey Bay and Salinas Valley groundwater basins, California*. (2011). USGS Fact Sheet: 2011-3089. Retrieved July 8, 2014, from <http://pubs.usgs.gov/fs/2011/3089/pdf/fs20113089.pdf>

Levy, Morgan, and Juliet Christian-Smith. (2011). *California Farm Water Success Stories: Groundwater Management in Pajaro Valley*. Pacific Institute. Retrieved July 10, 2014, from http://pacinst.org/wp-content/uploads/sites/21/2013/02/groundwater_management_in_pajaro_valley3.pdf

Metropolitan Water District of Southern California. (2007). *Groundwater Assessment Study: A Status Report on the Use of Groundwater in the Service Area of the Metropolitan Water District of Southern California*. Report Number 1308. Retrieved July 9, 2014, from <http://www.mwdh2o.com/mwdh2o/pages/yourwater/supply/groundwater/gwas.html>

Monterey County Water Resources Agency. (2006). *Monterey County Groundwater Management Plan*.

Monterey County Water Resources Agency. (2014). *Notice of Preparation – Salinas Valley Water Project, Phase II*.

Soquel Creek Water District and Central Water District. (2007). *Groundwater Management Plan – 2007 Soquel-Aptos Area*. Retrieved July 8, 2014, from http://www.soquelcreekwater.org/district-reports/GMP-2007/FinalDraft-2007_GMP.pdf

Santa Clara Valley Water District (SCVWD), San Benito County Water District (SBCWD), and Pajaro Valley Water Management Agency (PVWMA). (2014) *Pajaro River Watershed Integrated Regional Water Management Plan Update*. Retrieved July 28, 2014, from <http://www.pajaroriverwatershed.org/pdf/Pajaro%20IRWM%20Plan%20Update%202014.pdf>

Pajaro Valley Water Management Agency (PVWMA). (2014A). *Pajaro Valley Water Management Agency: Purpose*. Retrieved July 10, 2014, from <http://www.pvwma.dst.ca.us/about-pvwma/purpose.php>

Pajaro Valley Water Management Agency (PVWMA). (2014B). *Basin Management Plan Update – Final*. Prepared by Carollo Engineers.

RMC Water and Environment. (2014). *An Evaluation of California Groundwater Management Planning*. Prepared for the California Water Foundation.

San Luis Obispo County. *Groundwater Basin Newsletter*. (2011). Retrieved July 28, 2014, from <http://www.slocounty.ca.gov/Assets/PL/PR+Groundwater/newsletter.pdf>

Santa Barbara County Public Works Department. (2012). *Santa Barbara County 2011 Groundwater Report*. Retrieved July 7, 2014, from <http://www.countyofsb.org/uploadedFiles/pwd/Water/WaterAgency/Report%20Document%20FINAL.pdf>

Taylor, Dennis. (2014) Pajaro Valley Plan Targets Seawater Intrusion. *The Salinas Californian*. Retrieved July 27, 2014, from <http://www.thecalifornian.com/article/20140305/NEWS01/303050010/Pajaro-Valley-plan-targets-seawater-intrusion>

Ventura County. (2012). *2012 Groundwater Section Annual Report*. Retrieved July 10, 2014, from http://portal.countyofventura.org/portal/page/portal/PUBLIC_WORKS/Watershed_Protection_District/About_Us/VCWPD_Divisions/Water_and_Environmental_Resources/Groundwater_Resources/2012%20Groundwater%20Annual%20Report.pdf

Water in the West. (2014). *Before the Well Runs Dry: Improving the Linkage Between Groundwater and Land Use Planning*. Stanford University.